NASA CASE NO. LAR-13607-1-CU

PRINT FIG. 1

NOTICE

The invention disclosed in this document resulted from research in aeronautical and space activities performed under programs of the National Aeronautics and Space Administration. The invention is owned by NASA and is, therefore, available for licensing in accordance with the NASA Patent Licensing Regulation (14 Code of Federal Regulations 1245.2).

To encourage commercial utilization of NASA-owned inventions, it is NASA policy to grant licenses to commercial concerns. Although NASA encourages nonexclusive licensing to promote competition and achieve the widest possible utilization, NASA will consider the granting of a limited exclusive license, pursuant to the NASA Patent Licensing Regulations, when such a license will provide the necessary incentive to the licensee to achieve early practical application of the invention.

Address inquiries and all applications for license for this invention to NASA Patent Counsel, Langley Research Center, Mail Code 279, Langley Station, Hampton, VA 23665. Approved NASA forms for application for nonexclusive or exclusive license are available from the above address.

(NASA-Case-LAR-13607-1-CU) PERIOD OF LICENSING BEAGLE1 CHEMICALS IN SPACE Patent Application (NASA) 13 p CSCL 22A

LaRC
N88-29046

Unclas
G3/29 0159835

AWARDS ABSTRACT

LAR 13607-1 CU PATENT

METHOD OF DISPENSING REAGENT CHEMICALS IN SPACE

The invention relates to a method of slowly releasing reagent chemicals in space flight experiments.

The standard procedure for the controlled addition of chemicals in solutions is titration. The equipment is expensive, and the procedure requires operator attention and is subject to equipment failure. Titration is also not applicable in the microgravity conditions of space. This invention is inexpensive, does not require operator attention, and is not subject to equipment failure. Additionally, it is particularly suitable for space flight experiments.

The invention is a procedure whereby a liquid gel 10 is prepared, and a reagent chemical 12 is added while the gel is still liquid. The gel solution 18 thereby formed is poured into a storage container 20, and allowed to set. A desired amount of gel-tube 24 is dispensed in to a reaction solution 28, and the reagent chemical 12 slowly diffuses our of the gel-tube 24.

The novelty of the invention resides in the diffusion of a chemical through a gel that has been placed in a chemical solution. The invention is useful on earth because of its simplicity, low cost, and flexibility. It is useful in space flight experiments for a number of reasons. First, it can operate in a microgravity environment. Second, it can be used to transport and handle hazardous chemicals, since they would safely be confined in a set gel. Third, since any desired amount of chemicals can be added to a solution by varying the amount of gel dispensed, the invention provides the necessary flexibility for spare-based researchers.

Inventor: Patrick G. Barber
Address: Route 2, Box 29B
Keysville, VA 23947
SS#: 531-42-1863
Employer: Longwood College

James H. Coleman
P.O. Box 155
Prospect, Virginia 23960
SS#: 229-84-5199
Student

William J. Debnam
321 Beechmont Drive
Hampton, VA 23669
SS#: 229-52-4723
NASA-Langley Research Center
Initial Evaluator: Archibald Fripp

Serial No.: 210,445
Filed: June 23, 1988

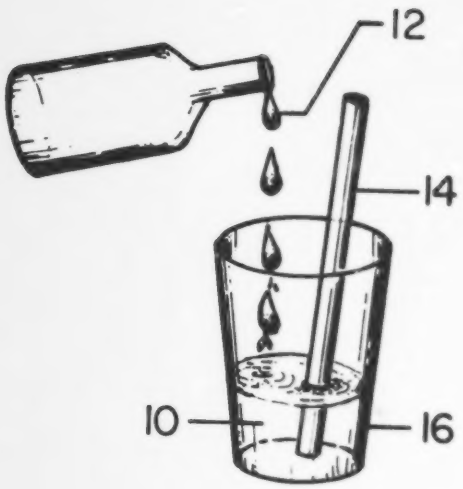


FIG. 1

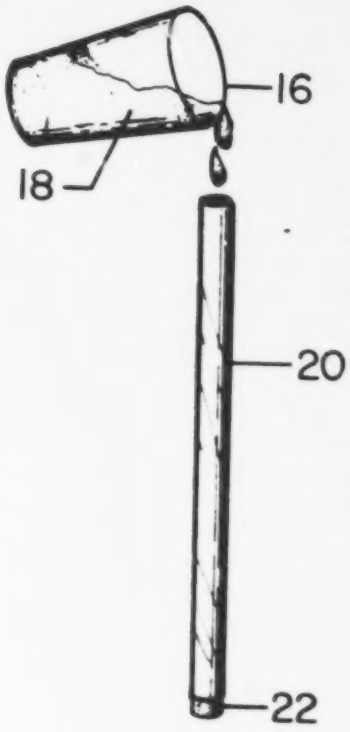


FIG. 2

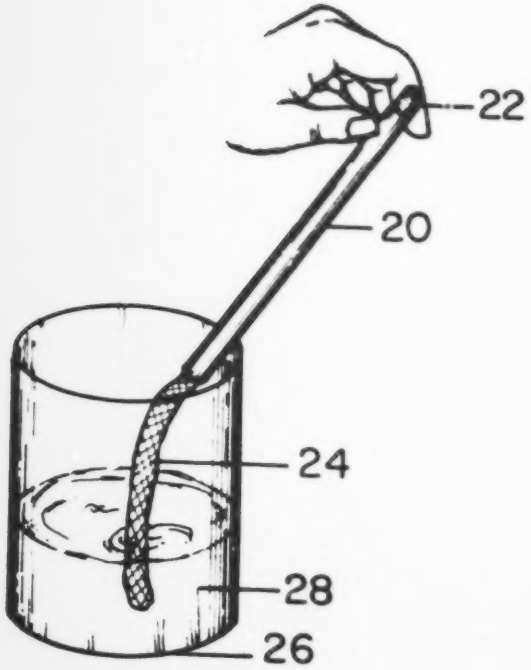


FIG. 3

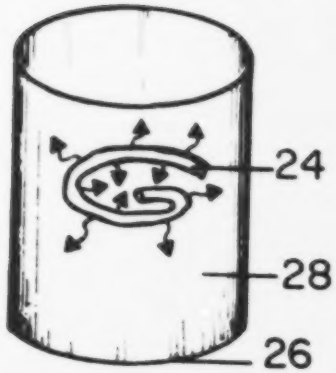


FIG. 4

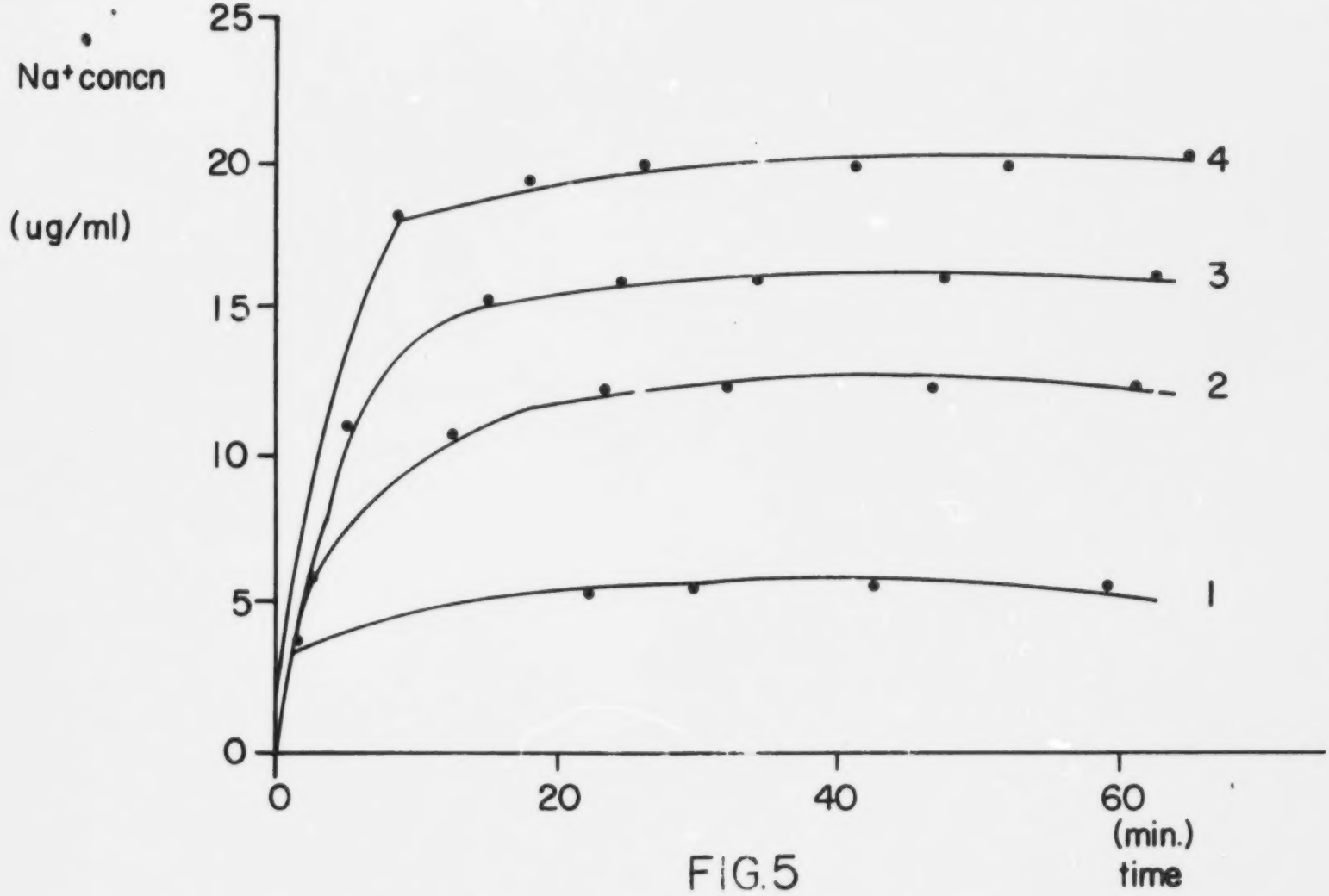
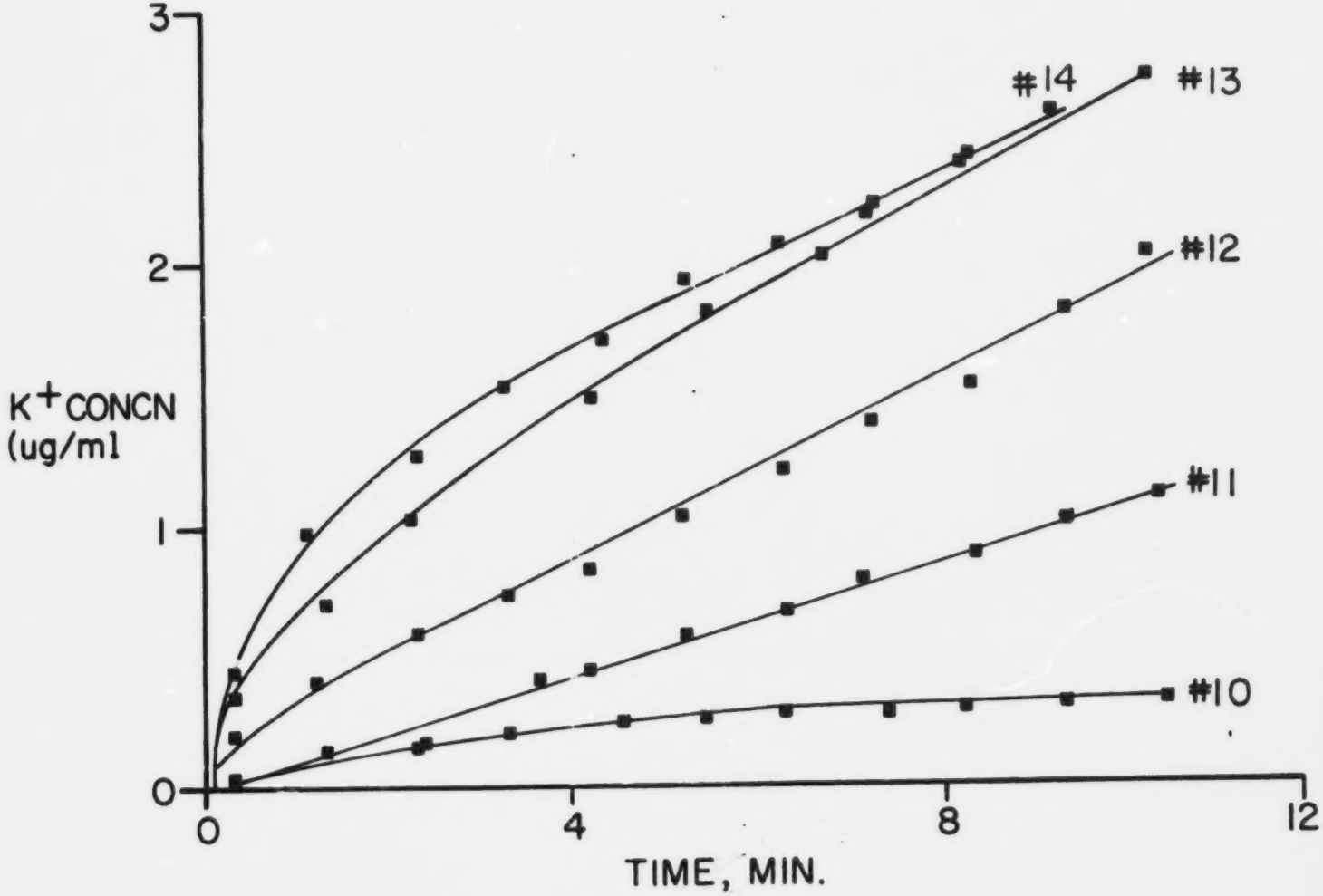


FIG.5


3
2
1
0
K+ CONCN
(ug/ml
#14
#13
#12
#11
#10
0
4
8
12
TIME, MIN.

METHOD OF DISPENSING REAGENT CHEMICALS IN SPACE

Origin of the Invention

The invention described herein was made in the performance of work under NASA Grant NAG-1-498. In accordance with 35 USC 202, the grantee elected not to retain title.

Field of the Invention

The present invention relates broadly to the controlled release of chemicals in solutions and more particularly to a method of slowly releasing reagent chemicals in space flight experiments.

Background of the Invention

The standard procedure for the slow, controlled addition of reagent chemicals in solutions is titration. This requires the use of expensive and sophisticated titrating equipment, and operator attention. Additionally, the procedure is subject to equipment failure.

The present invention is a procedure for the slow release of reagent chemicals in solutions that is simple, inexpensive, does not require operator attention, and is not subject to equipment failure.

The above characteristics of the procedure are particularly suitable for material processing experiments in space, such as crystal growth and analysis. Many material processing experiments require the slow release of chemicals in solutions under microgravity conditions. In addition, many of the chemicals are highly corrosive or toxic. The difficulty of handling and confining these chemicals makes Earth-based procedures, such as titration, not applicable.

Objects of the Invention

It is an object of this invention to provide a simple

method of controllably releasing reagent chemicals in solutions.

It is a further object of this invention to controllably release reagent chemicals in solutions in space flight experiments.

It is a further object of this invention to safely transport hazardous chemicals from earth to earth orbit.

It is a further object of this invention to safely allow the handling and confining of hazardous chemicals in space.

Other objects and advantages of this invention will become apparent hereinafter in the specification and drawings which follow.

Summary of the Invention

According to the present invention, the foregoing and additional objects are obtained by providing a method of controllably releasing chemicals in solutions from a gel. A liquid gel is first made in a open ended container. A desired amount of chemical is then added to the gel while the gel is still liquid. The gel solution thereby formed is poured into a storage container that is capable of dispensing a set gel. After allowing the gel solution to set, a desired amount of the gel solution is dispensed into a reaction solution. The chemical within the gel solution will then controllably diffuse out of the gel solution into the reaction solution.

Brief Description of the Drawings

FIG. 1 is an illustration of a reagent chemical being added to a liquid gel in accordance with the invention;

FIG. 2 is an illustration of a gel solution being poured into a storage container in accordance with the invention;

FIG. 3 is an illustration of a set gel solution being dispensed into a reaction solution in accordance with the invention;

FIG. 4 is an illustration of a reagent chemical diffusing out of a gel solution into a reaction solution;

FIG. 5 is a graph of the concentration of sodium ion in solution as a function of time, see Example 1; and

FIG. 6 is a graph of the concentration of potassium ion in solution as a function of time, see Example 2.

Detailed Description of the Invention

FIGS. 1-4 illustrate a preferred embodiment according to the invention. Referring now to FIG. 1, a liquid gel 10 is made in a first beaker 16. Suitable gels include organic and inorganic gels, such as gelatin, agar, carboxymethyl cellulose (cmc), and silica gel. While the gel 10 is liquid, a desired amount of reagent chemical 12 is added to the gel 10 within the beaker 16. The total amount of reagent chemical 12 that is added depends on the density of the gel 10, and the concentration and nature of the reagent chemical 12. A stirring rod 14 is used to mix the reagent chemical 12 and gel 10 together.

Referring now to FIG. 2, the resulting liquid gel solution 18 is poured into an ordinary "soda" straw 20 that has a cork 22 sealing one end. Toothpaste type tubes or pump dispensers may also be used. The gel solution 18 is then allowed to set.

Referring now to FIG. 3, the gel-tube 24, which is formed by allowing the gel solution 18 to set within the straw 20, is squeezed out into a reaction solution 28 within a second beaker 26. An alternate method is to cut off a piece of the straw 20, with the desired amount of gel solution 18 within, and placing the cut piece (not shown) within the reaction solution 28. Referring now to FIG. 4, the reagent chemical 12 slowly diffuses out of the gel-tube 24 into the reaction solution 28 over a period of time.

The rate of diffusion of the reagent chemical 12 depends on the density of the liquid gel 10. The diffusion rate decreases as the density of the gel increases. The total amount of reagent chemical 12 released into the reaction solution 28 depends on the amount of reagent

chemical 12 that was added to the liquid gel 10, and on the portion of gel-tube 24 that was squeezed into the reaction solution 28.

The invention is particularly useful in space flight experiments for three reasons. First, unlike the prior art, it can controllably release chemicals in a solution in a microgravity environment. Second, because the potentially hazardous chemicals are mixed in a set gel, they can be transported safely into space, and can be handled and confined without posing a hazard. Third, since any desired amount of chemicals can be added to a solution by varying the amount of gel dispensed, the invention provides the necessary flexibility for space-based researchers.

The invention is also useful on earth because of its simplicity, low cost, and flexibility.

Examples

The following examples are merely illustrative of the present invention and they should not be considered as limiting the scope of the invention in any way, as the full scope of possible embodiments of the invention will become apparent to those versed in the art in light of the present disclosure and accompanying claims.

Example 1: Sodium Ion

A stock gel was made by dissolving 3.63 grams of 275 Bloom gelatin, purchased from Fisher Chemical Company, in 100.00 milliliters of boiling deionized water. This solution formed a gel upon cooling to room temperature. The stock gel was kept in a refrigerator until use, at which time it was liquefied by heating.

A stock solution of sodium ion was made by dissolving 0.9511 grams of reagent grade sodium chloride in 50.0 milliliters of water. This corresponds to a solution with a sodium ion concentration of 7.48 milligrams per milliliter.

Four gel solutions were then prepared using various volumes of the stock sodium ion solution and 5.00

milliliters of the stock gel. The gel solutions prepared are summarized in Table 1.

Table 1
Sodium Ion in Cel

Gel Solution Number	Volume of Sodium Ion Solution	Concentration of Sodium Ion in gel	Weighed Amount of gel used
1	0.50 ml	0.62 mgNa/g	1.91 g
2	1.00	1.13	2.05
3	1.50	1.57	1.95
4	2.00	1.94	2.19

Each gel solution was poured into a separate plastic soda straw and allowed to solidify. The four straws were then refrigerated to retard any biological degradation of the gel.

A weighed amount of gel from each straw, as listed in Table 1, was separately placed into 200.00 milliliters of deionized water. The gel and straw were placed in a solution together. The resulting concentration of the sodium ion in each solution, as a function of time, is shown in Figure 5. The measured concentrations after twenty hours, and the theoretical maximum concentrations of sodium ion in the solutions are shown in Table 2.

Table 2
Concentrations of Sodium Ion

Gel Solution Number	Measured Final Concentration	Theoretical Maximum Concentration
1	6.0 ug/ml	5.9 ug/ml
2	13.4	11.6
3	16.8	15.3
4	20.9	21.3

Example 2: Potassium Ion

The procedure for making an ion solution, preparing the gels, and placing the gels in deionized water followed in Example 1 was repeated. In this example 1.50 grams of reagent grade potassium chloride was dissolved in 50.0 milliliters of deionized water to make a stock solution of potassium ion. This corresponds to a solution with a potassium ion concentration of 15.71 milligrams potassium ion per milliliter.

Five gel solutions were prepared, as summarized in Table 3. The concentration of potassium ions as a function of time after being placed in the deionized water is summarized in Figure 6 and Table 4.

Table 3

Potassium Ion in Gel

Gel Solution Number	Volume of Potassium Ion Solution	Concentration of Potassium in gel	Weighed Amount of gel used
10	0.25 ml	0.68 mgK/g	0.89 g
11	0.50	1.30	0.95
12	1.00	2.40	0.98
13	1.50	3.30	0.99
14	2.00	4.08	0.91

Table 4

Concentrations of Potassium Ion

Gel Solution Number	Measured Final Concentration	Theoretical Maximum Concentration
10	2.98 ug/ml	3.0 ug/ml
11	4.83	6.2
12	8.8	11.7
13	13.0	16.3
14	15.8	18.6

The data shows that the potassium ion does not come out of the gel as readily as does the sodium ion described in Example 1. This is because the potassium ion is larger than sodium ion.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

METHOD OF DISPENSING REAGENT CHEMICALS IN SPACE

Abstract of the Invention

A procedure for the slow, controlled release of a reagent chemical in a reaction solution. A liquid gel 10 is prepared, and a reagent chemical 12 is added while the gel is still liquid. The gel solution 18 thereby formed is poured into a storage container 20, and allowed to set. A desired amount of gel-tube 24 is dispensed into a reaction solution 28, and the reagent chemical 12 slowly diffuses out of the gel-tube 24.